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(19)

(54) IMPROVEMENTS IN THE PRODUCTION OF PROTEIN FROM NON-DILUTED OR DILUTED POTATO CORM WATER

(71) We, KONINKLIJKE SCHOLTEN-HONIG N.V., a Dutch body corporate, of Lagedijk 3, Koog aan de Zaan, the Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

The present invention relates to improvements in the production of water-soluble protein from non-diluted or diluted potato corm water. One aspect of the present invention consists in the production of protein with an improved colour and better taste.

The utilization of potato corm water is of considerable importance to industries which process potatoes, such as potato starch and potato chips industries, in that valuable by-products such as proteins, amino acids can be recovered and water pollution by process waste waters can be reduced. Potato corm water normally contains about 5% dry substance consisting of proteins, peptides, amino acids, sugars and minerals. Processes of the prior art concern the heat coagulation of the protein by the introduction of steam into non-concentrated potato corm water (which contains about 1.5% heat coagulable protein) and separation of the heat coagulated protein. These processes are less economic because of the expenditure of steam and the large equipment needed to treat the non-concentrated corm water. It is also known to coagulate the protein in corm water concentrated by evaporation and to separate the coagulated protein. This results, however, in less pure and coloured protein products. Further, processes are known in which the protein is recovered by concentrating the potato corm water e.g. by vacuum evaporation and drying the concentrated corm water. The thus obtained protein products are of low purity and stability because they contain all other components of the potato corm water i.e. amino acids, organic acids, inorganic salts, sugars, etc.

Although the known processes are useful for the production of protein from potato corm water, it has been found that advantages and improvements such as a more efficient production of protein and the manufacture of a better soluble protein product with improved colour and better taste can be achieved by concentrating the potato corm water in a first step by ultra filtration.

According to the present invention there is provided a process for the production of water-soluble protein from potato corm water in which non-diluted or diluted potato corm water is subjected to ultra filtration and the protein is recovered in the dry, water-soluble form from the concentrate obtained in the ulta filtration step by drying of the concentrate. To this end the product temperature should be kept below 100°C. Preferably the water-soluble protein is recovered by subjecting the concentrate obtained in the ultra filtration step to spray drying. It is also possible, though less desirable, to dry the concentrate on heated drums.

Any non-diluted or diluted potato corm water liberated in the processing of potatoes can be used as a starting material for the ultra filtration step. By way of example, in the potato starch industry the potato corm water can be obtained by pressing out or centrifuging the grated material resulting after grating the potatoes. Preferably potato corm water is used, which has been obtained by removing the fibres by means of an imperforate bowl conveyor discharge centrifuge from a mixture of potato corm water and fibres liberated in the process according to published Dutch Patent Application No. 72.00127. These centrifuges are for instance described in Kirk-Othmer, Encyclopedia of Chemical Technology, New York, 1964,

Vol. 4, pag. 745–746. The Dutch Application describes a method for recovering slightly diluted potato corm water in which the potatoes are grated and in which the grated substance is separated in a mixture of potato corm water and fibres and a starch suspension by means of hydrocyclones.

The potato corm water may be pretreated before it is subjected to ultra filtration, such as varying the pH over a wide range (pH 2–12). For instance calcium hydroxide may be added, whereby phosphates and other impurities are precipitated. These can be removed by filtration or centrifugation. It is also possible to heat the potato corm water, e.g. by injection of live steam, to a temperature of 50–65°C, in order to inactivate enzymes or to precipitate a fraction which contains color precursors. The preheated protein water must be cooled to a temperature of 50°C or lower and may be clarified before being passed to the ultra filtration step. These pretreatments improve the colour and taste of the proteins to be recovered.

Care should be taken that the potato corm water which is pumped into the ultra filtration equipment is essentially free of foam. This can be arranged by separating any existing foam from the liquid by means of known equipment, such as deforming tanks.

The ultra filtration as applied in the process according to the present invention is a membrane process in which the pore size is the principal determinant in the separation mechanism. For the treatment of potato corm water, membranes are selected with such permeability and retention characteristics as to retain the protein and to pass the non-protein components of the potato corm water. Suitable membranes for this purpose are for instance membranes consisting of cellulose acetate, or synthetic polymers such as polyamides or polymers or copolymers of acrylonitrile, vinylidene chloride, vinyl chloride and other vinyl monomers. Thus in the ultra filtration of potato corm water, non protein substances and water are driven by pressure through the membrane, thereby giving a concentrate containing predominantly the proteins and a permeate containing the non-protein material such as peptides, amino acids, sugars and inorganic salts. The pressure used is about 40 to 250 psi, preferably 40 to 150 psi. The volume of concentrate recovered can be varied from 1/2 to 1/10 of the original volume of potato fruit water, and preferably is 1/4 to 1/6 of the original volume.

Depending upon the membranes used and the recovery rate the flux may be in the order of 5–1 $cm^3/cm^2/h$. This value is preferably kept above 3 $cm^3/cm^2/h$. Since the flux diminishes during a run as a result of fouling of the membranes, the ultra filtration has to be stopped at regular intervals for cleaning purposes to restore the initial flux. The cleaning is done in situ by treatment with water containing enzymes, detergents and/or oxidizing agents and other rinsing compounds. Very good results are obtained with cleaning with diluted sodium hypochlorite solutions, containing up to 4500 ppm chlorine. Since synthetic membranes are not damaged by such treatment, in contradistinction to cellulose acetate membranes, the use of the former membranes is highly preferred. The ultra filtration concentrate of potato corm water is an attractive starting material for the recovery of protein since the proportion of contaminating non-protein material is lowered through ultra-filtration. Protein recovered by drying the concentrate will be of higher purity than protein obtained from corm water concentrated by evaporation. The ultra filtration concentrate is preferably spray dried in the form of a clear solution obtained by the removal of suspended particles, e.g. starch, fibres or protein, by filtration or centrifugation. A better product results when the concentrate is diluted with pure water and the so diluted concentrate is subjected to ultra filtration. This sequence may be repeated any desired number of times to obtain a very pure protein concentrate. A very pure protein is obtained when the concentrate is acidified, the precipitated protein is removed by filtration and the filtrate is subjected to diafiltration, i.e. ultra filtration during which fresh water is continuously and preferably countercurrently added to the concentrate, to wash out the non-protein impurities. In addition, however, it has been found that the ultra filtration concentrate can efficiently be dried to a water-soluble protein, which protein dissolves much easier and more completely in water than known potato protein products, when the product is dried at temperatures below which substantial denaturation of the protein occurs. It is therefore an embodiment of the present invention to recover water-soluble protein by subjecting the concentrate obtained in the ultra filtration step by spray drying, preferably such that the product temperature remains below 100°C. Various types of spray dryer installations are suitable for carrying out the spray drying of the concentrate. The spray drying unit can be provided with an atomization system consisting of a two-fluid nozzle, a single-fluid nozzle or a centrifugal disk atomizer. The spray drying apparatus can be designed to dry the sprayed droplets in a stream of hot air or inert gas countercurrently or cocurrently with the sprayed droplets. The inlet temperature of the hot gas may vary from 100°C to 300°C, preferably using such conditions that the temperature of the product remains

below 100°C. During the spray drying of the concentrate much less coloration of the product and less fouling of the apparatus occur than in drying whole potato fruit water which has been concentrated by evaporation.

The protein obtained in our process is white so slightly grey and dissolves easily and substantially completely in water of room temperature. It is also possible to dry the concentrate on heated drums, preferably provided the product temperature remains below 100°C. For this purpose several types of drum dryers can be used such as single and double drum dryers. The concentrate can be applied to the heated drum by spraying onto the drum, by means of dip feed, top feed by one or more applicator rolls or by means of valley feed for a double drum dryer. Suitable drum dryers are described in: Whistler and Paschall: Starch: Chemistry and Technology, Vol. II, page 524–528, New York 1967. Preferably vacuum drum drying is used at drum temperatures from 60°C to 100°C. However, spray drying is preferred, because the protein obtained by drying on heated drums has a darker colour and is less soluble in water in comparison to the spray dried product.

As stated above, the invention provides an advantageous process for producing soluble protein from potato fruit water, which protein is better soluble in water and less colored and has a neutral taste. This is of special importance for the application of the functional properties of potato protein to human nutrition. The permeate of the ultra filtration step can be concentrated by reverse osmosis and/or evaporation and dried on heated drums.

The following examples are given by way of illustration of the present invention only and are not intended to limit the invention in any way.

Example I

Potato corm water obtained in a process for manufacturing starch according to published Dutch Patent Application No. 72.00127 and freed from fibres by means of an imperforated bowl conveyor discharge centrifuge was defoamed and subjected to ultra filtration in equipment provided with tubular ultra filtration membranes. The pressure in the system was 135 psi at an initial flux of 4 $cm^3/cm^2/h$. The membrane used was a cellulose acetate membrane type 215 of Fluid Sciences. The concentrate had a volume of one-fourth of the original volume of the potato corm water.

The concentrate so obtained was filtered by means of screening giving a clear filtrate. Spray drying was carried out in a Niro atomizer spray drying unit provided with a nozzle and in which the droplets are dried in a cocurrent stream of hot air. The inlet temperature was 150–160°C, and the outlet temperature 85°C. The protein so recovered consisted of a slightly greyish powder which dissolved easily after stirring into water of room temperature. The product contained 71% protein and had a nitrogen solubility index of 79% and had a bland taste. On drying the concentrate on a single drum dryer, the drum having a temperature of 120°C, a protein product was obtained which had a darker colour and dissolved less easily in water than a spray dried product.

Example II

Potato corm water separated from grated potatoes to which sulfur dioxide has been added in an imperforate bowl conveyor discharge centrifuge was subjected to steam injection through which the temperature was raised to 58°C. The pretreated corm water was filtered to remove the precipitated material and after defoaming pumped at a temperaure of 40°C into an ultra filtration unit having polyacrylonitrile membranes. The membranes are cleaned in situ with a sodium hypochlorite solution containing 3000 ppm of active chlorine to keep the flux at a value of at least 3 $cm^3/cm^2/h$. The concentrate, which had a volume of one-fifth of the original volume of the potato corm water, was divided into two portions. One portion was spray dried as in Example I. The product was nearly white. It contained 75% protein and the nitrogen solubility index was 83%.

The other portion was acidified by adding hydrochloric acid. The precipitate thus formed was filtered off and after suspending in water spray dried, giving a product containing 72% protein. The inlet temperature was 165° and the outlet temperature 90°C. The filtrate was again subjected to ultra filtration, fresh water being added continuously to the recirculating concentrate. When the washing procedure was stopped and the liquid had been concentrated to one-fourth of its original volume it was spray dried. The inlet temperature was 165°C and the outlet temperature 90°C. The white protein thus obtained contained 77% protein and the nitrogen solubility index was 86%. The taste of the product is neutral.

WHAT WE CLAIM IS:–

1. A process for the production of water-soluble protein from potato corm water, in which non-diluted or diluted potato corm water is subjected to ultra filtration and the protein is recovered in the dry, water-soluble form from the concentrate obtained in the ultra filtration step by drying of the concentrate.

2. A process as claimed in claim 1, in which the ultra filtration is performed at a pressure of 40 to 250 psi.

3. A process as claimed in claim 1 or claim 2, in which the concentrate recovered after ultra filtration is one-half to one-tenth of the original volume.

4. A process as claimed in any one of the preceding claims, in which the concentrate is dried by means of spray drying.

5. A process as claimed in claim 4, in which the concentrate is spray dried at a gas inlet temperature of from 100°C to 300°C.

6. A process as claimed in any one of the preceding claims, in which the concentrate obtained by ultra filtration is acidified, the precipitated protein is removed and the filtrate is subjected to diafiltration and thereafter spray dried.

7. A process as claimed in any one of claims 1 to 3, in which the concentrate obtained by ultra filtration is dried in vacuum on a heated drum at drum temperatures of 60–100°C.

8. A process as claimed in any one of claims 1 to 6, in which the concentrate obtained by ultra filtration is subjected at least once to a sequence of diluting with pure water and subjecting the so diluted concentrate to ultra filtration, and thereafter spray dried.

9. A process as claimed in any one of the preceding claims, in which the concentrate is dried such that the product temperature remains below 100°C.

10. A process as claimed in any one of the preceding claims, in which the concentrate is clarified by filtratio or centrifugation before drying.

11. A process as claimed in any one of the preceding claims, in which the potato corm water is defoamed before it is subjected to ultra filtration.

12. A process as claimed in any one of the preceding claims, in which the flux during ultra filtration is kept above 3 $cm^3/cm^2/h$.

13. A process as claimed in claim 12, in which the flux is maintained above 3 $cm^3/cm^2/h$ by cleaning in situ with sodium hypochlorite, the ultra filtration membranes consisting of synthetic polymeric material.

14. A process as claimed in any one of the preceding claims, in which the pH of the potato corm water is adjusted to a value ranging from 2–12 and any precipitate thus formed is removed before ultra filtration.

15. A process as claimed in any one of the preceding claims, in which the potato corm water is heated to a temperature of 50–65°C and clarified and cooled to a temperature not higher than 50°C before ultra filtration.

16. A process for producing protein from potato corm water as claimed in claim 1 and substantially as described herein.

17. Protein whenever produced by a process as claimed in any one of claims 1 to 5.

18. Protein whenever produced by a process as claimed in any one of claims 6 to 16.

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